

IPv6 OSPFv3 Interoperability Test Specification

Version 1.0

CHT-TL
NIST

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MODIFICATION RECORD

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Overview

This document describes test specification to verify the interoperability among OSPFv3 routers. The major purpose of all test cases is to verify the target router (TR) will work well with different vendors' router. We put target router in different roles according to the OSPFv3 protocol.

There are 5 testing groups: The first group is about DR and BDR election. To make sure the target router can use Hellos and Database Descriptions to form adjacency and exchange link-state database with other target routers. The target router can be DR, BDR and DR-Other based on its Router ID and priority. The second group is Intra-area routes. To make sure the target router can use Router-LSAs, Network-LSAs, Intra-Area-Prefix-LSAs and Link-LSAs to build a route tree for this area. According to the route tree, it can find the shortest path to any node within this area. When the link state is changed, it is learned through Link State Update. The third group is Inter-Area routes. When the target router is an ABR, it learns other areas' routes via Inter-Area-Router-LSAs and forwards a packet to valid area scope. It can update the route tree when the link state is changed. It also tests Virtual links. The fourth group is External routes. When the target router is an ASBR, it learns and broadcasts other AS's prefixes via AS-External-LSAs. It also tests Stub areas. There are no AS-External-LSAs in stub area. The last group Authentication/Confidentiality is an optional test. Authentication has been removed from OSPFv3 because it relies on the IPv6 IPsec.

Requirements

- A target router must implement OSPFv3 function according to RFC 2328[1] and RFC 5340[2] .
- Authentication and confidentiality which are mentioned in RFC 4552[3] are optional functions.
- There must be at least **four** interfaces of each router.
- Each interface must support configuration of its cost, priority, area ID, router ID, IPv6 address and address prefix.
- The RUT must support broadcast link type.

References

The following documents are referenced in this specification:

- [1] RFC 2328, OSPF Version 2, J. Moy, April 1998.
- [2] RFC 5340, OSPF for Ipv6, R. Coltun, D. Ferguson, J. Moy, A. Lindem, Ed., July 2008.
- [3] RFC 4552, Authentication/Confidentiality for OSPFv3, M. Gupta, N. Melam, June 2006.
- [4] UNH-IOL, Open Shortest Path First version 3 (OSPFv3) Multi-System Interoperability Test Suite, version 1.6, University of New Hampshire – InterOperability Laboratory.

Abbreviation and Acronyms

This section provides definitions of the abbreviations and acronyms used in this test specification as well as terms based on telecommunications and standards.

ABR	Area Border Router
AS	Autonomous System
ASBR	Autonomous System Boundary Router
BDR	Backup Designated Router
DR	Designated Router
ESP	Encrypted Security Payload
IOT	Interoperability Test
LSA	Link State Advertisement
OSPF	Open Shortest Path First
RIP	Routing Information Protocol
RUT	Router Under Test
SAD	Security Association Database
SPD	Security Policy Database
SPI	Security Parameter Index
TR	Target Router

Common Configuration

The common configuration parameters of each router are shown on Table 1. The links IPv6 address prefix are shown on Table 2. The IPv6 address of reference hosts are shown on Table 3.

- *IPv6 Address*: A router's interfaces IPv6 address have a name convention: 2001:DB8:0:[LINK_NUMBER]:::[ROUTER_NUMBER]00. To assign IPv6 address manually is used by default and is a minimal requirement. EUI-64 address assignment is acceptable to be used by all test cases.
- *Autonomous System (AS)*: In group4, there are two ASs: AS100 and AS200. AS name on this specification is an example. To assign different AS names is acceptable.
- *Host Address*: A host has a naming convention - 2001:DB8:0:[LINK_NUMBER]::1. For example, the IPv6 address of H1 which connects to Link4 in AS100 is 2001:DB8:0:4::1. To assign IPv6 address manually is used by default and is a minimal requirement. IPv6 autoconfiguration address assignment is acceptable.
- *Router ID*: Router IDs are assigned by Table 1. It is acceptable to assign different Router IDs, except OSPFv3_IOT_1_1 and OSPFv3_IOT_1_2. In both test cases, it would specify the order of Router IDs.

Table 1 Routers Common Configuration Parameters Example

Router Number	Router Name	Router ID	Router IPv6 Address
1	TR1	1.1.1.1	2001:DB8:0:[LINK_NUMBER]::100
2	TR2	2.2.2.2	2001:DB8:0:[LINK_NUMBER]::200
3	TR3	3.3.3.3	2001:DB8:0:[LINK_NUMBER]::300

Table 2 Links Common Configuration Parameters

Link Number	Link Name	IPv6 Prefix/Prefix Length
1	Link1	2001:DB8:0:1::/64
2	Link2	2001:DB8:0:2::/64
3	Link3	2001:DB8:0:3::/64
4	Link4	2001:DB8:0:4::/64

Table 3 Hosts Common Configuration Parameters Example

Host Name	Host IPv6 Address
H1	2001:DB8:0:[LINK_NUMBER]::1
H2	2001:DB8:0:[LINK_NUMBER]::1
H3	2001:DB8:0:[LINK_NUMBER]::1

Group 1 DR/BDR

OSPFv3_IOT_1_1 DR/BDR Election based on Router ID

Purpose:

Check if the router becomes the DR, BDR or DR-Other is based on its Router ID.

References:

RFC 2328: section 7.3, section 7.4, section 9.4, section 9.4, section 9.5, section 10

RFC 5340: section 4.2.1, 4.2.2, Appendix A.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Three reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 1.
- Every router belongs to the same area.
- The priority of every router's interface which connects to Link2 is equal (greater than 0).
- TR3's Router ID should be the largest. TR2's Router ID should be the second largest. TR1 should be the smallest.
- **TR3's Router ID should be larger than 128.0.0.0.**
- All routers have the same HelloInterval (10) and RouterDeadInterval (40).

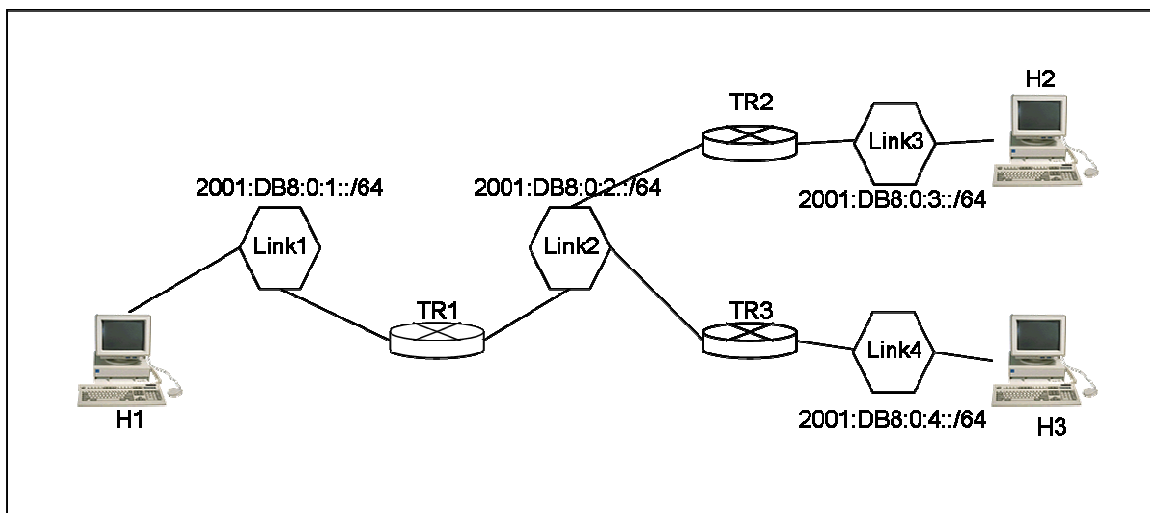


Figure 1 OSPFv3_IOT_1_1 Topology

Procedure:

Part A: DR/BDR Election (based on Router ID)



- 1 Disable OSPFv3 on all routers.
- 2 Enable OSPFv3 on TR1 and TR2.
- 3 Wait at least RouterDeadInterval.
- 4 On Link2, observe Hello packets from TR1 and TR2.
- 5 Observe the traffic transmitted from H1 to H2.

Part B: TR1 From DR-Other to BDR.

- 6 Disable OSPFv3 on all routers.
- 7 Enable OSPFv3 on TR2 and TR3.
- 8 Wait at least HelloInterval.
- 9 Enable OSPFv3 on TR1.
- 10 Wait to form adjacency.
- 11 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 12 Disable OSPFv3 on TR3.
- 13 Wait at least RouterDeadInterval.
- 14 On Link2, observe Hello packets from TR1 and TR2.
- 15 Enable OSPFv3 on TR3.
- 16 Wait to form adjacency.
- 17 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 18 Observe the traffic transmitted from H1 to H2.
- 19 Observe the traffic transmitted from H1 to H3.

Part C: TR1 From BDR to DR.

- 20 Disable OSPFv3 on all routers.
- 21 Enable OSPFv3 on TR2.
- 22 Wait at least RouterDeadInterval.
- 23 Enable OSPFv3 on TR1.
- 24 Wait to form adjacency.
- 25 Enable OSPFv3 on TR3.
- 26 Wait to form adjacency.
- 27 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 28 Disable OSPFv3 on TR2.
- 29 Wait at least RouterDeadInterval.
- 30 On Link2, observe Hello packets from TR1 and TR3.
- 31 Enable OSPFv3 on TR2.
- 32 Wait at least HelloInterval.
- 33 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 34 Observe the traffic transmitted from H1 to H2.
- 35 Observe the traffic transmitted from H1 to H3.

Observable Results:

- Part A:
- Step 4: TR1 is BDR and TR2 is DR on Link2.
 - Step 5: Traffic should be transmitted though Link1, Link2 and Link3.
- Part B:
- Step 11: TR1 is DR-Other, TR2 is BDR and TR3 is DR on Link2.
 - Step 14: TR1 is BDR and TR2 is DR on Link2.
 - Step 17: TR1 is BDR, TR2 is DR and TR3 is DR-Other on Link2.



- Step 18: Traffic should be transmitted though Link1, Link2 and Link3.
- Step 19: Traffic should be transmitted though Link1, Link2 and Link4.

Part C:

- Step 27: TR1 is BDR, TR2 is DR and TR3 is DR-Other on Link2.
- Step 30: TR1 is DR and TR3 is BDR on Link2.
- Step 33: TR1 is DR, TR2 is DR-Other and TR3 is BDR on Link2.
- Step 34: Traffic should be transmitted though Link1, Link2 and Link3.
- Step 35: Traffic should be transmitted though Link1, Link2 and Link4.

Possible Problems:

None.

OSPFv3_IOT_1_2 DR/BDR Election based on Router Priority

Purpose:

Check if the router becomes the DR, BDR or DR-Other is based on its Router priority.

References:

RFC 2328: section 7.3, section 7.4, section 9.4, section 9.5, section 10

RFC 5340: section 4.2.1, 4.2.2, Appendix A.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Three reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 2.
- Every router belongs to the same area.
- The priority of every router's interface which connects to Link2 is equal in the beginning (greater than 0).
- TR3's Router ID should be the largest. TR2's Router ID should be the second largest. TR1 should be the smallest.
- All routers have the same HelloInterval (10) and RouterDeadInterval (40).

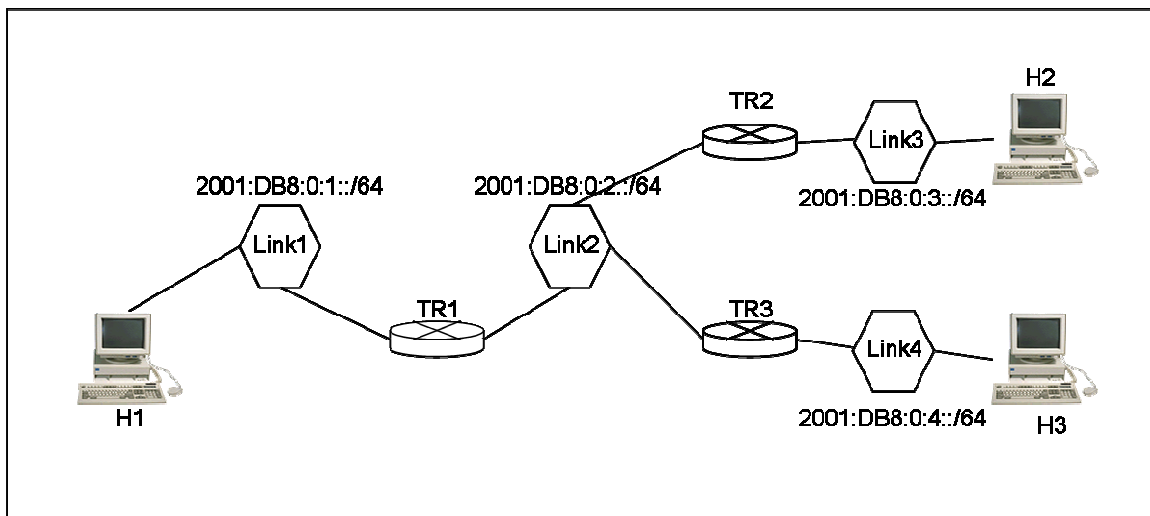


Figure 2 OSPFv3_IOT_1_2 Topology

Procedure:

Part A: DR/BDR Election (based on Router Priority)

- 1 Disable OSPFv3 on all routers.
- 2 On Link2, configure TR1's priority to 10.
- 3 On Link2, configure TR2's priority to 5.



- 4 On Link2, configure TR3's priority to 1.
- 5 The order of TR1, TR2 and TR3's Router ID is TR1 < TR2 < TR3.
- 6 Enable OSPFv3 on TR1 and TR2.
- 7 Wait at least HelloInterval.
- 8 Enable OSPFv3 on TR3.
- 9 Wait to form adjacency.
- 10 On Link2, observe Hello packets from TR1, TR2 and TR3.

Part B: The router's priority is set to 0.

- 11 Disable OSPFv3 on all routers.
- 12 On Link2, configure TR1's priority to 0.
- 13 The order of TR1, TR2 and TR3's Router ID is TR1 < TR2 < TR3.
- 14 On Link2, TR2's priority is 5, TR3's is 1.
- 15 Enable OSPFv3 on all routers.
- 16 Wait at least RouterDeadInterval.
- 17 On Link2, observe Hello packets from TR1, TR2 and TR3.

Observable Results:

Part A: • Step 10: TR1 is DR, TR2 is BDR and TR3 is DR-Other.

Part B: • Step 17: TR1 is DR-Other, TR2 is DR and TR3 is BDR on Link 2.

Possible Problems:

None.

OSPFv3_IOT_1_3 Hello Protocol, Hello Packet Mismatch

Purpose:

Check if the router correctly participates in the Hello Protocol and that any mismatch between the Hello packets causes the packets to be dropped.

References:

RFC 2328: section 10.5

RFC 5340: section 4.2.1, 4.2.2.1, Appendix A.3.2

UNH-IOL: TEST OSPFv3_INTEROP.1.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Three reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 3.
- Every router belongs to the same area.
- All routers have the same HelloInterval (10) and RouterDeadInterval (40) in the beginning.

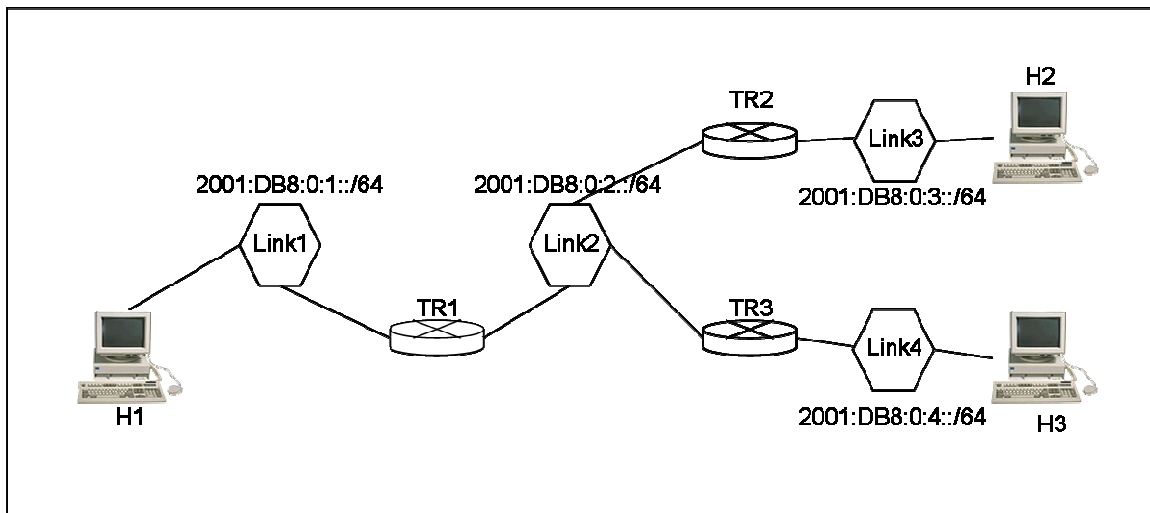


Figure 3 OSPFv3_IOT_1_3 Topology

Procedure:

Part A: Hello Mismatch, Different HelloInterval.

- 1 Disable OSPFv3 on all routers.
- 2 Configure the TR1, TR2 and TR3 to have the same Area ID and RouterDeadInterval values.
- 3 Configure the TR1 to have a different HelloInterval than TR2 and TR3.

- 4 Enable OSPFv3 on all routers.
- 5 Wait to form adjacency.
- 6 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 7 Observe the traffic transmitted from H1 to H2.
- 8 Observe the traffic transmitted from H1 to H3.

Part B: Hello Mismatch, Different RouterDeadInterval.

- 9 Disable OSPFv3 on all routers.
- 10 Configure the TR1, TR2, and TR3 to have the same Area ID and HelloInterval values.
- 11 Configure the TR1 to have a different RouterDeadInterval than TR2 and TR3.
- 12 Enable OSPFv3 on all routers.
- 13 Wait at to form adjacency.
- 14 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 15 Observe the traffic transmitted from H1 to H2.
- 16 Observe the traffic transmitted from H1 to H3.

Part C: Hello Mismatch, Different Area ID.

- 17 Disable OSPFv3 on all routers.
- 18 Configure the TR1, TR2 and TR3 to have the same RouterDeadInterval and HelloInterval values.
- 19 Configure the TR1 to have a different Area ID than TR2 and TR3.
- 20 Enable OSPFv3 on all routers.
- 21 Wait to form adjacency.
- 22 On Link2, observe Hello packets from TR1, TR2 and TR3.
- 23 Observe the traffic transmitted from H1 to H2.
- 24 Observe the traffic transmitted from H1 to H3.

Observable Results:

- Part A:
- Step 6: TR1 should not become neighbors with TR2 and TR3. TR1 should not synchronize its database with TR2 and TR3.
 - Step 7: Traffic should not be transmitted from H1 to H2 through Link2.
 - Step 8: Traffic should not be transmitted from H1 to H3 through Link2.
- Part B:
- Step 14: TR1 should not become neighbors with TR2 and TR3. TR1 should not synchronize its database with TR2 and TR3.
 - Step 15: Traffic should not be transmitted from H1 to H2 through Link2.
 - Step 16: Traffic should not be transmitted from H1 to H3 through Link2.
 -
- Part C:
- Step 22: TR1 should not become neighbors with TR2 and TR3. TR1 should not synchronize its database with TR2 and TR3.
 - Step 23: Traffic should not be transmitted from H1 to H2 through Link2.
 - Step 24: Traffic should not be transmitted from H1 to H3 through Link2.

Possible Problems:

None.

Group 2 Intra-Area Routes

OSPFv3_IOT_2_1 Select the Shortest Path within the Same Area

Purpose:

Check if the router determines the shortest path within the same area.

References:

RFC 2328: section 13, section 16.1

RFC 5340: section 2.3, section 4.5, section 4.8.1

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 4.
- On Link4, the interface cost of TR2 is 50. All others are 1 in the beginning.
- Every router belongs to the same area.

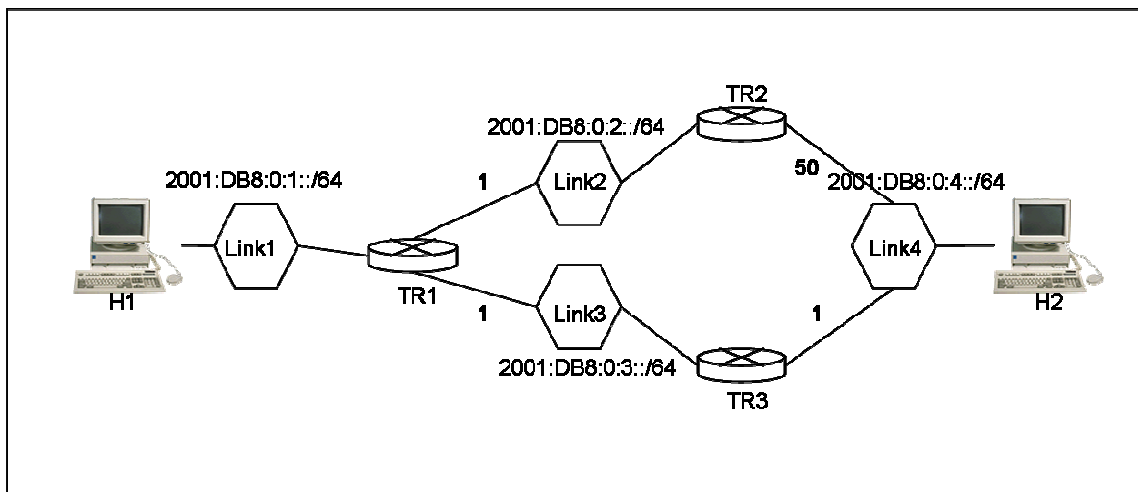


Figure 4 OSPFv3_IOT_2_1 Topology

Procedure:

Part A: Select the shortest path.

- 1 Enable OSPFv3 on all routers.
- 2 Wait to form adjacency.
- 3 Observe the traffic transmitted from H1 to H2.

Part B: Alternate the path cost.

- 4 Disable OSPFv3 on all routers.
- 5 On Link4, configure the interface cost of TR3 from 1 to 100.



- 6 Enable OSPFv3 on all routers.
- 7 Wait to form adjacency.
- 8 Observe the traffic transmitted from H1 to H2.

Part C: Change route after original path fail.

- 9 Disable OSPFv3 on all routers.
- 10 On Link4, configure interfaces cost of TR3 to 100 and TR2 to 50.
- 11 Enable OSPFv3 on all routers.
- 12 Wait to form adjacency.
- 13 Disable OSPFv3 on TR2.
- 14 Wait at least RouterDeadInterval.
- 15 Observe the traffic transmitted from H1 to H2.
- 16 Enable OSPFv3 on TR2.
- 17 Wait to form adjacency.
- 18 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 3: Traffic should be transmitted through Link1, Link3 and Link4.

Part B: • Step 8: Traffic should be transmitted through Link1, Link2 and Link4.

Part C: • Step 15: Traffic should be transmitted through Link1, Link3 and Link4.
 • Step 18: Traffic should be transmitted through Link1, Link2 and Link4.

Possible Problems:

None.

Group 3 Inter-Area Routes

OSPFv3_IOT_3_1 Select the Shortest Path within the Same AS

Purpose:

Check if the router determines the shortest path within Inter-area routes.

References:

RFC 2328: section 13, section 16.2

RFC 5340: section 2.3, section 4.5, section 4.8.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 5.
- On Link4, the interface cost of TR2 is 50. All others are 1 in the beginning.
- TR1, TR2 and TR3 are ABRs.

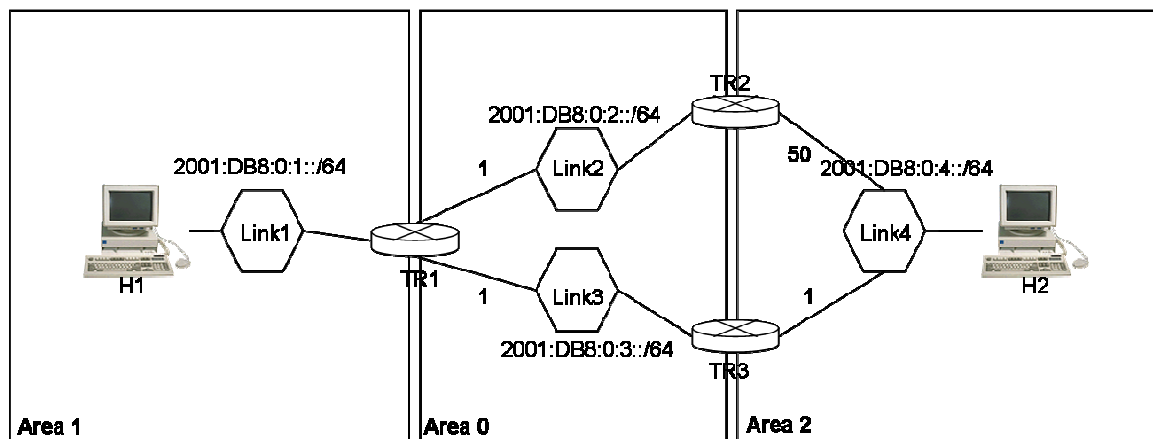


Figure 5 OSPFv3_IOT_3_1 Topology

Procedure:

Part A: Select the shortest path.

- 1 Enable OSPFv3 on all routers.
- 2 Wait to form adjacency.
- 3 Observe the traffic transmitted from H1 to H2.

Part B: Alternate the path cost.

- 4 Disable OSPFv3 on all routers.
- 5 On Link4, configure the interface cost of TR3 from 1 to 100.
- 6 Enable OSPFv3 on all routers.



- 7 Wait to form adjacency.
- 8 Observe the traffic transmitted from H1 to H2.

Part C: Change route after original path fail.

- 9 Disable OSPFv3 on all routers.
- 10 On Link4, configure the interfaces cost of TR3 to 100 and TR2 to 50.
- 11 Enable OSPFv3 on all routers.
- 12 Wait to form adjacency.
- 13 Disable OSPFv3 on TR2.
- 14 Wait at least RouterDeadInterval.
- 15 Observe the traffic transmitted from H1 to H2.
- 16 Enable OSPFv3 on TR2.
- 17 Wait to form adjacency.
- 18 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 3: Traffic should be transmitted through Link1, Link3 and Link4.

Part B: • Step 8: Traffic should be transmitted through Link1, Link2 and Link4.

Part C: • Step 15: Traffic should be transmitted through Link1, Link3 and Link4.
 • Step 18: Traffic should be transmitted through Link1, Link2 and Link4.

Possible Problems:

None.

OSPFv3_IOT_3_2 Virtual Link Connecting a Remote Area

Purpose:

Check if the remote area router can connect with the backbone area via a virtual link.

References:

RFC 2328: section 15

RFC 5340: section 4.7

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 6.
- TR1 and TR2 are ABRs.
- TR3 belongs to backbone area.

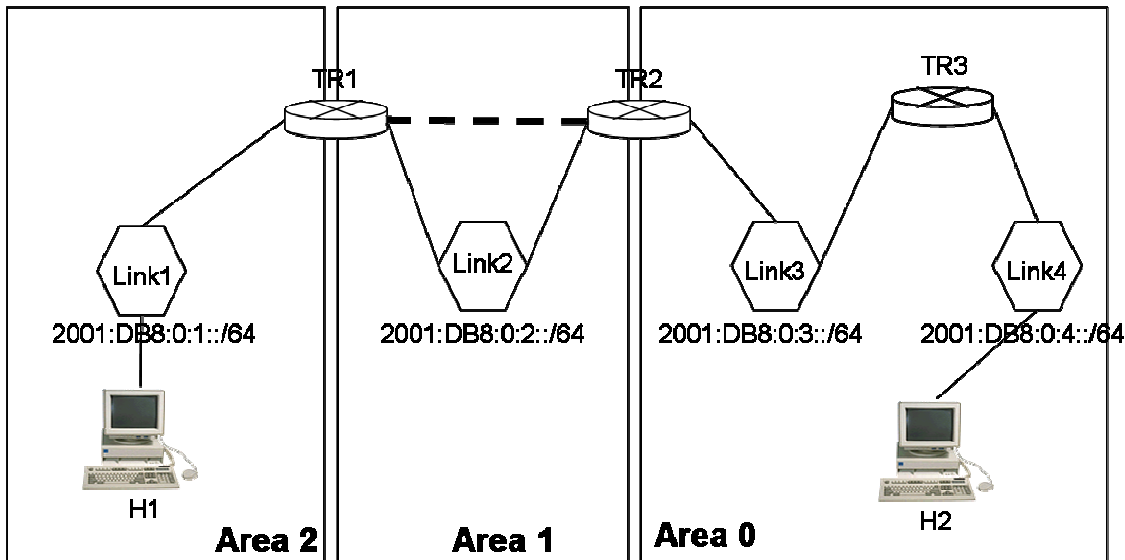


Figure 6 OSPFv3_IOT_3_2 Topology

Procedure:

Part A: Remote Area Without Virtual Link.

1. Enable OSPFv3 on all routers.
2. Wait to form adjacency.
3. Observe the traffic transmitted from H1 to H2.
4. Observe the traffic transmitted from H2 to H1.

Part B: Remote Area with Virtual Link.

5. Configure virtual link between TR1 and TR2 in area 1.



6. Wait at least HelloInterval.
7. Observe the traffic transmitted from H1 to H2.
8. Observe the traffic transmitted from H2 to H1.
9. Remove virtual link between TR1 and TR2.
10. Wait at least HelloInterval.
11. Observe the traffic transmitted from H1 to H2.
12. Observe the traffic transmitted from H2 to H1.

Observable Results:

- Part A:
- Step 3: Traffic should not be transmitted from H1 to H2.
 - Step 4: Traffic should not be transmitted from H2 to H1.
- Part B:
- Step 7: Traffic should be transmitted through Link1, 2, 3, and 4.
 - Step 8: Traffic should be transmitted through Link4, 3, 2 and 1.
 - Step 11: Traffic should not be transmitted from H1 to H2.
 - Step 12: Traffic should not be transmitted from H2 to H1.

Possible Problems:

None.

OSPFv3_IOT_3_3 Intra-Area Route Preference

Purpose:

Check if the router makes the correct routing decisions when both intra-area and inter-area routes are available.

References:

RFC 2328: section 3.2, section 16.2(6)

RFC 5340: section 2.3

UNH-IOL: TEST OSPFv3_INTEROP.3.1

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 7.
- On Link4, the interface cost of TR3 is 50. All others are 1.
- TR1 and TR2 are ABRs.

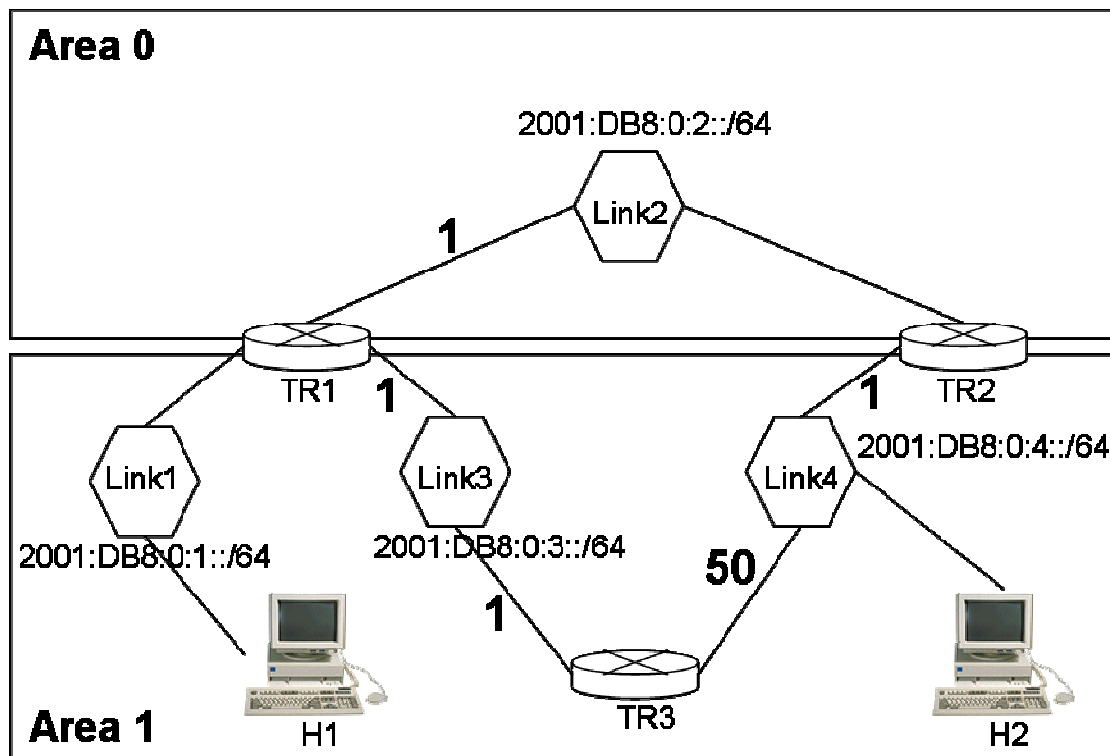


Figure 7 OSPFv3_IOT_3_3 Topology



Procedure:

Part A: Intra-Area Route Preference.

1. Enable OSPFv3 on all routers.
2. Wait to form adjacency.
3. Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 3: Traffic should be transmitted through Link 1, 3 and 4.

Possible Problems:

None.

Group 4 External Routes

OSPFv3_IOT_4_1 Stub Area

Purpose:

Check if the ABR which belongs to the stub area blocks AS-External-LSAs into it.

References:

RFC 2328: section 3.6, section 4.2, section 4.5, section 9.5

RFC 5340: section 2.10, section Appendix A.4.5

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 8.
- Area 1 is a stub area.
- TR2 is an ABR.
- TR3 is an ASBR.
- On Link4, the interface cost of TR3 is 10.
- Link4 belongs to another AS.

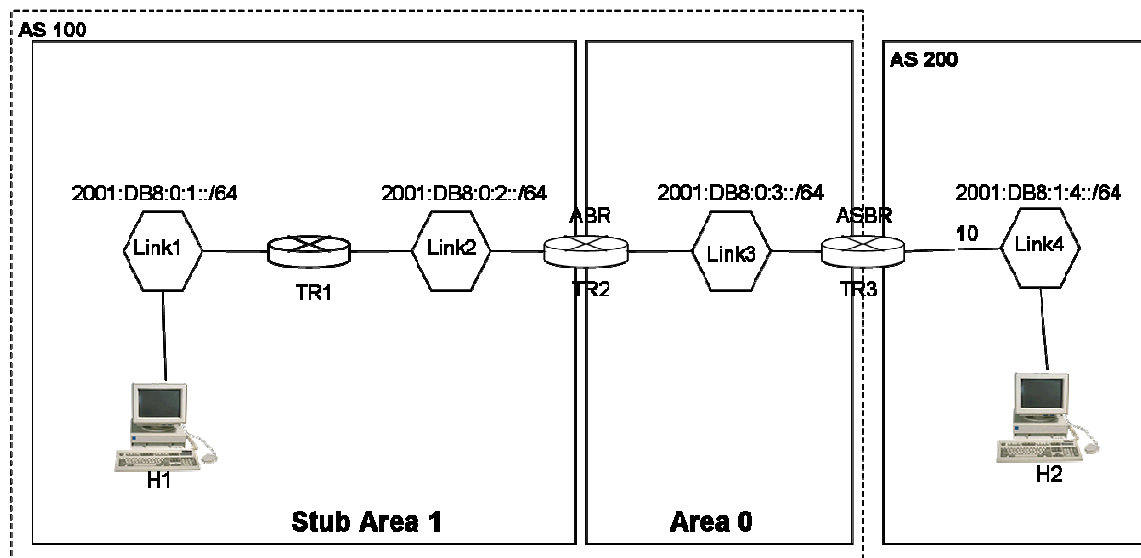


Figure 8 OSPFv3_IOT_4_1 Topology

Procedure:

Part A: No route information in Stub area.

- 1 Enable OSPFv3 on all routers.



- 2 Wait to form adjacency.
- 3 Configure TR3 to redistribute Link4 static route (Type 1) without forwarding address into AS100.
- 4 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 4: Traffic should be transmitted through Link1, Link2, Link3 and Link4.

Possible Problems:

None.

OSPFv3_IOT_4_2 Type1/Type2 External Routes (ASBR)

Purpose:

Check if the router determines the shortest path which is based on type 1 and type 2 external metrics of ASBR.

References:

RFC 2328: section 2.3, section 11, section 16.4

RFC 5340: section 4.4.3.6

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 9.
- TR2 and TR3 are ASBRs.
- On Link2, the interface cost of TR1 is 100.
- On Link3, the interface cost of TR1 is 10.
- On Link4, the interfaces cost of TR2 is 20 and TR3 is 50.
- Link4 belongs to another AS.

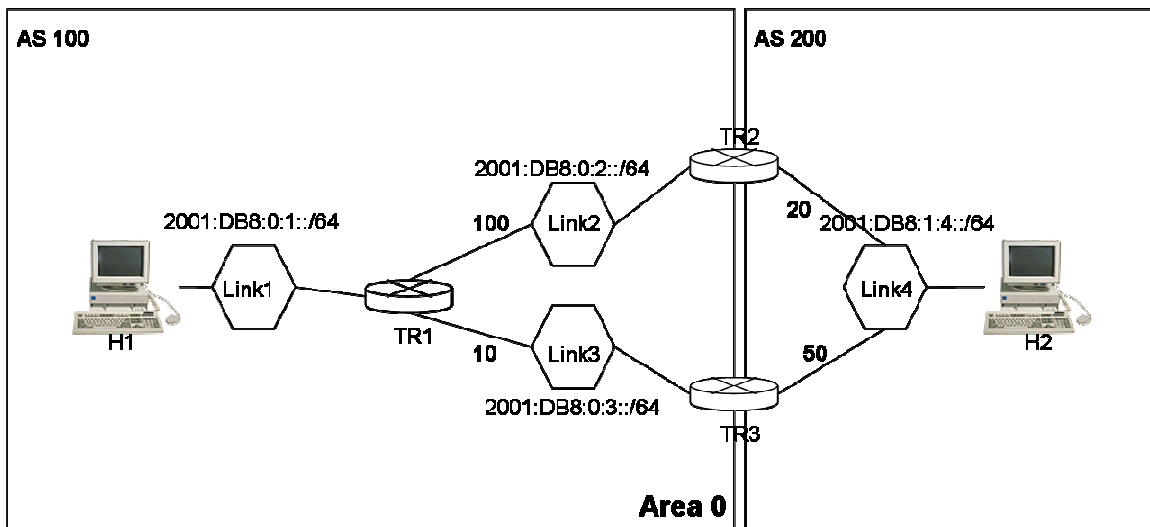


Figure 9 OSPFv3_IOT_4_2 Topology

Procedure:

Part A: Type 2 External Metrics.

- 1 Enable OSPFv3 on all routers.
- 2 Wait to form adjacency.



- 3 Configure TR2 and TR3 to redistribute Link4 external (Type2) route into AS100 without forwarding address.
- 4 Observe the traffic transmitted from H1 to H2.

Part B: Type 1 External Metrics.

- 5 Disable OSPFv3 on all routers.
- 6 Enable OSPFv3 on all routers.
- 7 Wait to form adjacency.
- 8 Configure TR2 and TR3 to redistribute Link4 static route (Type 1) into AS100 without forwarding address.
- 9 Observe the traffic transmitted from H1 to H2.

Part C: Type 1 external metrics always take precedence.

- 10 Disable OSPFv3 on all routers.
- 11 Enable OSPFv3 on all routers.
- 12 Wait to form adjacency.
- 13 Configure TR2 to support Type 1 External metric.
Configure TR3 to support Type 2 External metric.
Both redistribute Link4 static route into AS100.
- 14 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 4: Traffic should be transmitted through Link1, Link2 and Link4.

Part B: • Step 9: Traffic should be transmitted through Link1, Link3 and Link4.

Part C: • Step 14: Traffic should be transmitted through Link1, Link2 and Link4.

Possible Problems:

None.

OSPFv3_IOT_4_3 Intra-AS Paths to ASBR Preference: Larger Area ID is Chosen

Purpose:

Check if the router makes the correct routing decision within an Autonomous System across multiple areas. The route with the largest area ID is chosen.

References:

RFC 2328: section 16.4, section 6.4.1

RFC 5340: section 2.3, section 4.8.5

UNH-IOL: TEST OSPFv3_INTEROP.3.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 10.
- On Link2, the interface cost of TR1 is 50.
- On Link3, the interface cost of TR1 is 50.
- TR2 is an ASBR.
- TR1 is an ABR.
- Link4 belongs to another AS.

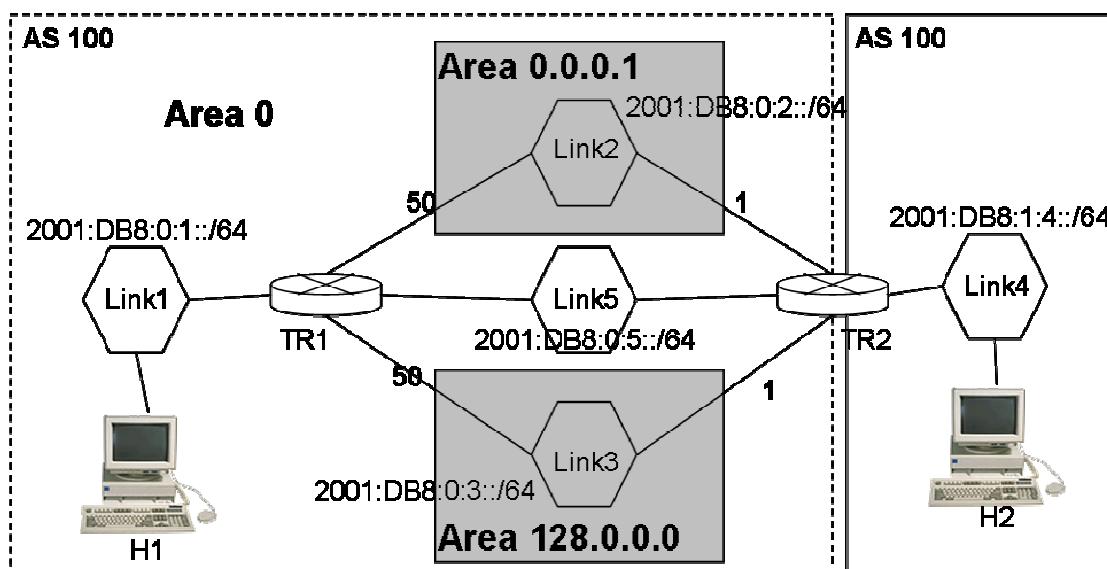


Figure 10 OSPFv3_IOT_4_3 Topology

Procedure:



Part A: Larger Area ID is chosen.

- 1 Enable OSPFv3 on both routers.
- 2 Wait to form adjacency.
- 3 Configure TR2 to redistribute external route (Link4) into AS100 without forwarding address.
- 4 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 4: Traffic should be transmitted through Link1, Link3 and Link4.

Possible Problems:

None.

OSPFv3_IOT_4_4 Intra-AS Paths to ASBR Preference: Non-Backbone Areas are Preferred

Purpose:

Check if the router makes the correct routing decision when multiple intra-AS are available to ASBR address. Intra-area paths using non-backbone areas are always the most preferred.

References:

RFC 2328: section 16.4, section 6.4.1

RFC 5340: section 2.3, section 4.8.5

UNH-IOL: TEST OSPFv3_INTEROP.3.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 11.
- On Link2, the interface cost of TR1 is 50.
- On Link3, the interface cost of TR1 is 50.
- TR2 is an ASBR.
- TR1 is an ABR.
- Link4 belongs to another AS.

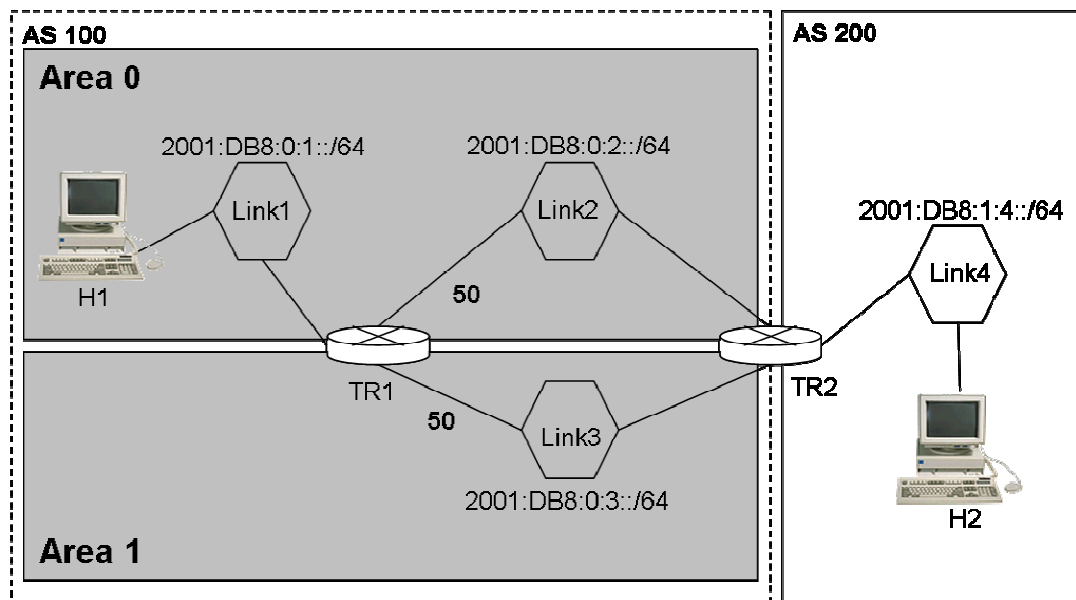


Figure 11 OSPFv3_IOT_4_4 Topology



Procedure:

Part A: Intra-area paths using non-backbone areas are preferred.

- 1 Enable OSPFv3 on both routers.
- 2 Wait to form adjacency.
- 3 Configure TR2 to redistribute external route (Link4) into AS100 without forwarding address.
- 4 Observe the traffic transmitted from H1 to H2.

Observable Results:

Part A: • Step 4: Traffic should be transmitted through Link1, Link3 and Link4.

Possible Problems:

None.

OSPFv3_IOT_4_5 Inter-Area Routes Through Transit Areas

Purpose:

Check if the router makes the correct routing decisions within an Autonomous System across transit areas.

References:

RFC 2328: section 3.2, section 15, section 16.2, section 16.2, section 16.3

RFC 5340: section 2.3, section 4.8.4

UNH-IOL: TEST OSPFv3_INTEROP.3.3

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Three reference hosts

Test Setup:

- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 12.
- On Link2, the interface cost of TR1 is 50. All others are 1.
- TR3 is an ASBR.
- TR1 and TR2 are ABRs.
- Link5 belongs to another AS.

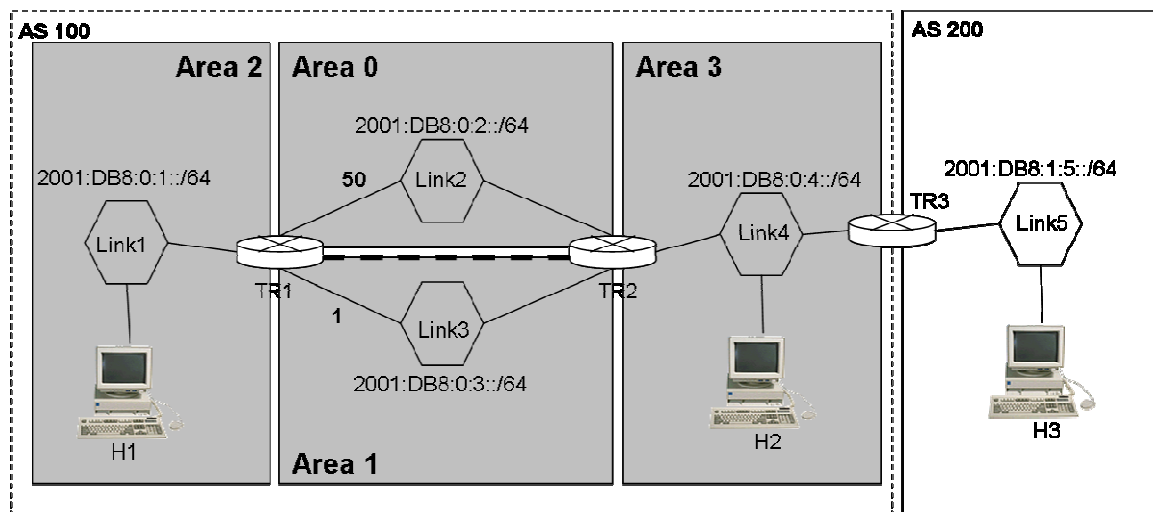


Figure 12 OSPFv3_IOT_4_5 Topology

Procedure:

Part A: No Virtual Link.

- 1 Enable OSPFv3 on all routers.
- 2 Wait to form adjacency.
- 3 Observe the traffic transmitted from H1 to H2.



- 4 Configure TR3 to redistribute external route (Link5) into AS100 without forwarding address.
- 5 Observe the traffic transmitted from H1 to H3.

Part B: With Virtual Link.

- 6 Disable OSPFv3 on all routers.
- 7 Enable OSPFv3 on all routers.
- 8 Configure a virtual link between TR1 and TR2 in area 1.
- 9 Observe the traffic transmitted from H1 to H2.
- 10 Configure TR3 to redistribute external route (Link5) into AS100 without forwarding address.
- 11 Observe the traffic transmitted from H1 to H3.

Part C: No Path to Backbone Area.

- 12 Disable OSPFv3 on all routers.
- 13 No virtual link between TR1 and TR2 in area 1.
- 14 Disconnect TR1 to Link2.
- 15 Observe the traffic transmitted from H1 to H2.
- 16 Configure TR3 to redistribute external route (Link5) into AS100 without forwarding address.
- 17 Observe the traffic transmitted from H1 to H3.

Observable Results:

- Part A:
- Step 3: Traffic should be transmitted through Link1, Link2 and Link4.
 - Step 5: Traffic should be transmitted through Link1, Link2, Link4 and Link5.
- Part B:
- Step 9: Traffic should be transmitted through Link1, Link3 and Link4.
 - Step 11: Traffic should be transmitted through Link1, Link3, Link4 and Link5.
- Part C:
- Step 15: TR1 should have no route to Link4.
 - Step 17: TR1 should have no route to TR3.

Possible Problems:

None.



Group 5 Authentication/Confidentiality (optional)

In OSPFv3, authentication has been removed from the protocol. OSPFv3 relies on the IP AH and IP ESP to ensure authentication and confidentiality of routing exchange. The major purpose of this testing group is to make sure different vendors' router can cooperate with each other when IPSEC is enabled.

OSPFv3_IOT_5_1 ESP on an Interface (Transport Mode)

Purpose:

Check routers of different vendors can exchange OSPFv3 routing packets when ESP is enabled on each router. This test is only for link base, not area base.

References:

RFC 5340: section 2.6

RFC 4552

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- On Link2, both inbound and outbound SAs of TR1 and TR2 are shown on Table 4.
- On Linke2, both inbound and outbound SPD of TR1 and TR2 are shown on Table 5, Table 6, Table 7 and Table 8. **For some devices, SPD may not need to be configured.**
- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 13.
- All routers belong to the same area.

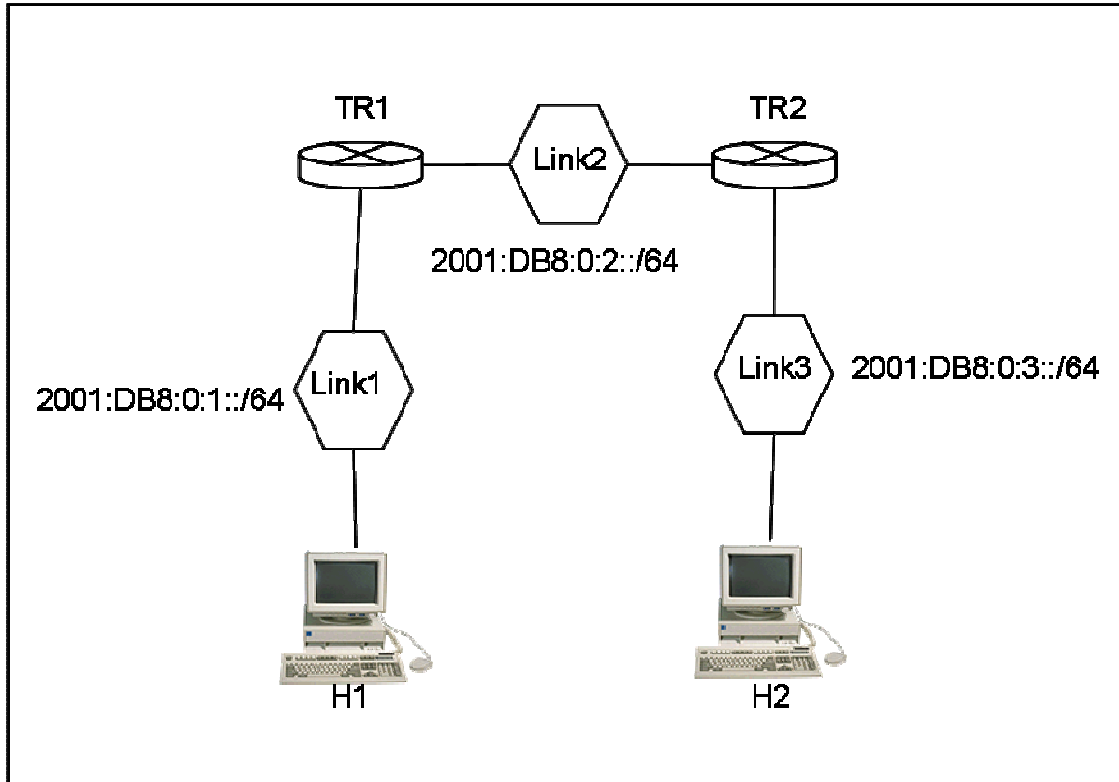


Figure 13 OSPFv3_IOT_5_1 Topology

Table 4 Security Association Database (SAD) for both inbound and outbound

SPI	0x1000
mode	Transport
protocol	ESP
ESP algorithm	3DES-CBC
ESP key (192 bits)¹	0x0123456789abcdef0123456789abcdef0123456789abcdef
ESP authentication algorithm	HMAC-SHA1
ESP authentication key (160 bits)¹	0x123456789a123456789b123456789c123456789d

Table 5 TR1 Security Policy Database (SPD) for inbound

Source Address	The interface link local address of TR2 on Link2
Destination Address	Any
Direction	In
Protocol	ESP/OSPF
Mode	Transport

¹ RFC 4552 section 12: The implementations MUST allow the administrator to configure the cryptographic and authentication keys in hexadecimal format rather than restricting it to a subset of ASCII characters (letters, numbers, etc.).

Table 6 TR1 Security Policy Database (SPD) for outbound

Source Address	The interface link local address of TR1 on Link2
Destination Address	Any
Direction	Out
Protocol	ESP/OSPF
Mode	Transport

Table 7 TR2 Security Policy Database (SPD) for inbound

Source Address	The interface link local address of TR1 on Link2
Destination Address	Any
Direction	In
Protocol	ESP/OSPF
Mode	Transport

Table 8 TR2 Security Policy Database (SPD) for outbound

Source Address	The interface link local address of TR2 on Link2
Destination Address	Any
Direction	Out
Protocol	ESP/OSPF
Mode	Transport

Table 9 New Security Association Database (SAD) for both inbound and outbound

SPI	0x2000
mode	Transport
protocol	ESP
ESP algorithm	3DES-CBC
ESP key (192 bits)¹	0x9876543210abcdef9876543210abcdef9876543210abcdef
ESP authentication algorithm	HMAC-SHA1
ESP authentication key (160 bits)¹	0x987654321a987654321b987654321c987654321d

Procedure:

Part A: With ESP on both Peers.

- 1 Enable OSPFv3 on both routers.
- 2 On Link2, enable ESP of TR1 and TR2. SAD is shown on Table 4.
- 3 Observe packets on Link2.
- 4 Wait to form adjacency.
- 5 Observe the traffic transmitted from H1 to H2.

Part B: Discard Un-protected Packets.

- 6 On Link2, disable ESP of TR1 and TR2.
- 7 Disable OSPFv3 on both routers.
- 8 Enable OSPFv3 on both routers.
- 9 On Link2, enable ESP of TR1 only. SAD is shown on Table 4.

- 10 Wait at least RouterDeadInterval.
- 11 Observe the traffic transmitted from H1 to H2.
- 12 On Link2, enable ESP of TR2. SAD is shown on Table 4.
- 13 Wait to form adjacency.
- 14 Observe the traffic transmitted from H1 to H2.

Part C: Rekeying.

- 15 On Link2, disable ESP of TR1 and TR2.
- 16 Disable OSPFv3 on both routers.
- 17 Enable OSPFv3 on both routers.
- 18 On Link2, enable ESP of TR1 and TR2. SAD is shown on Table 4.
- 19 Observe packets on Link2.
- 20 At H1, continuing to transmit packets to H2 (without stop).
- 21 Configure SA to new SA on TR1 and TR2. The new SA is shown on Table 9.
- 22 Observe the traffic transmitted from H1 to H2.
- 23 At H1, stop transmitting packets to H2..

Observable Results:

- Part A:
- Step 3: OSPFv3 Packets are encrypted.
 - Step 5: Traffic should be transmitted through Link1, Link2 and Link3.
- Part B:
- Step 11: Traffic should not be transmitted from H1 to H2.
 - Step 14: Traffic should be transmitted through Link1, Link2 and Link3.
- Part C:
- Step 19: OSPFv3 packets are encrypted.
 - Step 22: H2 receives packets from H1 without stop. OSPFv3 packets are encrypted. Traffic should be transmitted through Link1, Link2 and Link3.

Possible Problems:

The router can not accept hexadecimal ESP and authentication keys.

OSPFv3_IOT_5_2 ESP on a Virtual Link (Transport Mode)

Purpose:

Check routers of different vendors can exchange OSPFv3 routing packets when ESP is enabled on each router's virtual link interface. This test is only for link base, not area base.

References:

RFC 2328: section 2.6, section 15, section 16

RFC 5340: section 4.7

RFC 4552

Resource Requirements:

- Three target routers (three different vendors)
- Monitor to capture packets
- Two reference hosts

Test Setup:

- Both inbound and outbound SAs which are shown on Table 4 are the same.
- Both inbound and outbound SPD of virtual link peers are shown on Table 10, Table 11, Table 12 and Table 13. **For some devices, SPD may not need to be configured.**
- The configuration of parameters and physical routers are shown on Table 1, Table 2, Table 3 [refer to page 3] and Figure 14.
- TR1 and TR2 are ABRs.
- TR3 belongs to the backbone area.

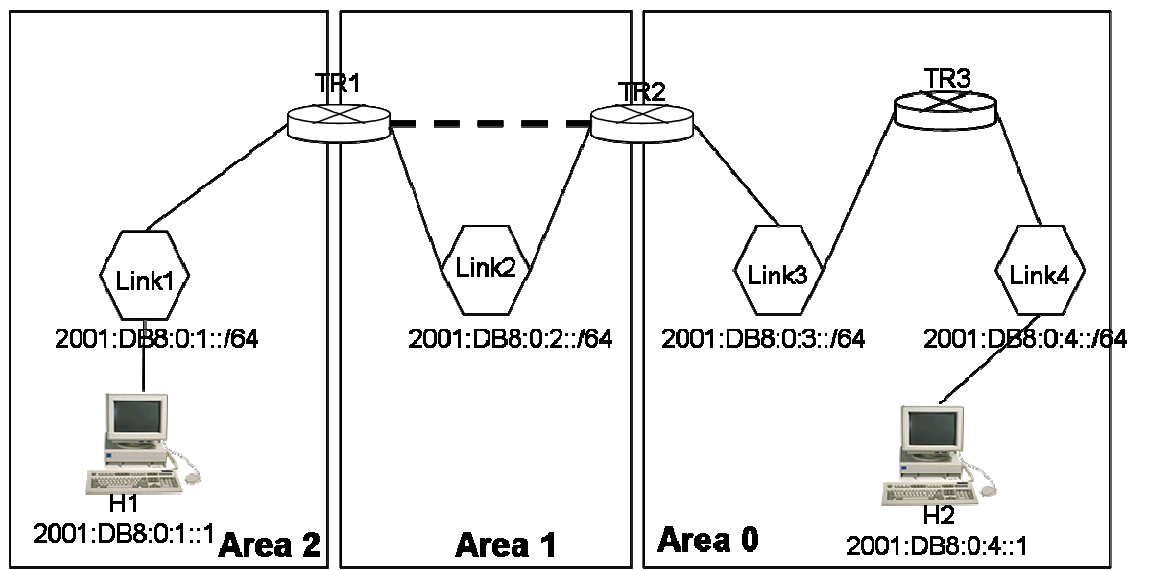


Figure 14 OSPFv3_IOT_5_2 Topology

Table 10 TR1 Security Policy Database (SPD) for inbound

Source Address	The interface IPv6 global address of TR2 on Link2
Destination Address	The interface IPv6 global address of TR1 on Link2
Direction	In
Protocol	ESP/OSPF
Mode	Transport

Table 11 TR1 Security Policy Database (SPD) for outbound

Source Address	The interface IPv6 global address of TR1 on Link2
Destination Address	The interface IPv6 global address of TR2 on Link2
Direction	Out
Protocol	ESP/OSPF
Mode	Transport

Table 12 TR2 Security Policy Database (SPD) for inbound

Source Address	The interface IPv6 global address of TR1 on Link2
Destination Address	The interface IPv6 global address of TR2 on Link2
Direction	In
Protocol	ESP/OSPF
Mode	Transport

Table 13 TR2 Security Policy Database (SPD) for outbound

Source Address	The interface IPv6 global address of TR2 on Link2
Destination Address	The interface IPv6 global address of TR1 on Link2
Direction	Out
Protocol	ESP/OSPF
Mode	Transport

Procedure:

Part A: Virtual Link With ESP in Both Peers.

- 1 Disable OSPFv3 on all routers.
- 2 Enable OSPFv3 on all routers.
- 3 Configure virtual link between TR1 and TR2 with ESP in area 1.
- 4 Observe packets on Link2.
- 5 Wait at least HelloInterval.
- 6 Observe the traffic transmitted from H1 to H2.

Part B: Virtual link With ESP in One Peer.

- 7 Enable OSPFv3 on all routers.
- 8 Wait to form adjacency.
- 9 Configure a virtual link from TR1 to TR2 with ESP in area 1.
- 10 Configure a virtual link from TR2 to TR1 without ESP in area 1.
- 11 Wait for at least HelloInterval.
- 12 Observe the traffic transmitted from H1 to H2.



Observable Results:

- Part A:
- Step 4: Virtual link packets are encrypted.
 - Step 6: Traffic should be transmitted through Link1, Link2, Link3 and Link4.
- Part B:
- Step 12: Traffic should not be transmitted from H1 to H2.

Possible Problems:

The router can not accept hexadecimal ESP and authentication keys.